

## Appendix 1

### Recommendations to the Transport Airplanes and Engines Issues Group (TAEIG) from the Flight Guidance Systems Harmonization Working Group (FGSHWG)

The FGSHWG identified a number of regulatory issues in the process of conducting its activities in response to the Terms of Reference provided by TAEIG. These issues have been developed into recommendations for additional work, or for further consideration, as the activity was considered outside of the scope of work for the FGSHWG. Some of the issues may need further coordination between the regulatory authorities and Industry to determine if, or how, to proceed. This Appendix documents those recommendations and requests that TAEIG consider the information provided in its response to the FAA and JAA is response to the ARAC tasking.

- 1) The FGSHWG was tasked to:

*Review recommendations that stem from recent transport aviation events and relate to crew error, cockpit automation and in particular, automatic flight control/guidance made by the NTSB, the FAA Human Factors Team, and the JAA Human Factors Steering Group.*

The Group found it necessary to limit the scope of its work and determined it was not in the Group's purview to address the human factors and potential crew confusion issues associated with flight management systems. The Group did address the FGS crew confusion and error issues relating to use of a FGS. In doing so, the FGS interface with an FMS was addressed. However, the Group agreed that a similar activity should be undertaken to address similar crew confusion and error issues associated with FMS operations.

**Recommendation** – Consideration should be given to producing an AC/ACJ, or similar material, that provides guidance on human machine interface issues associated with the use of flight management systems (FMS).

- 2) The FGSHWG was tasked to:

*Harmonize acceptable methods of demonstrating compliance with FGS requirements and to propose relevant language for the next revision of the flight test guide AC 25-7(x).*

The JAA does not have an equivalent document to AC 25-7A. The Working Group decided to produce an Appendix to the 25.1329 AC/ACJ that documents flight test procedures related to the update to the 25.1329 rule and the associated guidance material. The JAA members have indicated a preference to make the 'Flight Test' Appendix a second ACJ or AMJ to the rule. The FAA would update AC 25-7A to include the addition material.

Note: The Working Group has used a philosophy of the "What needs to be evaluated" material goes in the body of the AC/ACJ and the "How to evaluate" material goes in the Flight Test Guide, or ACJ/AMJ Appendix.

**Recommendation** – The FAA should consider the material provided in the Flight Test Appendix of the proposed AC/ACJ 25.1329 for integration into AC 25-7A. Care should be taken to ensure that the connectivity between AC/ACJ 25.1329 and AC 25-7A is maintained during that integration. Additionally, the structure of both documents should be carefully considered such that there is little or no duplication of FGS test procedures between the two, and it is readily apparent what material resides in each document. The relative timing and implications of the issuance of AC/ACJ 25.1329 and a revision to AC 25- 7A needs to be considered.

- 3) The Working Group has attempted to address the overlap in criteria in current autopilot and All Weather Operations [AWO] material. The low visibility aspects have been removed from AC/ACJ 25.1329 and deferred

to the appropriate AWO material. This activity was anticipated as part of the work of the All Weather Operations Harmonization Working Group that shares a significant number of members with the FGSHWG. The effectiveness and consistency of the joint work of the two groups should be reviewed.

**Recommendation** - Advisory Circulars 120-28D and 120-29A should be reviewed and possibly amended such that the two ACs are consistent with new §25.1329 provisions contained in this package, and that there is no conflicting material contained in those Advisory Circulars and the proposed AC/ACJ 1329. The JAA AWOSG should be tasked to produce Category I criteria consistent JAR ACJ 25.1329 and to review and amend JAR AWO Subparts, as necessary.

- 4) The FGSHWG was tasked to:

*Review §25.1329/1335, JAR paragraphs 25.1329/1335 plus the material contained in NPA 25F-243 in addition to §121.579, and the associated Advisory Circulars 25.1329-1 and ACJ 25.1329. Update and harmonize the Part 25 §/paragraphs and the associated guidance material, in the light of the review of regulatory materials, current certification experience, and changes in technology and system design.*

In reviewing FAR 121.579, the Working Group found an inconsistency with current autopilot operations and the operational objectives identified by the Commercial Aviation Safety Team (CAST). This involves the calculation of the autopilot Minimum Use Height (MUH). The Working Group undertook a proposed revision to FAR 121.579 to make it compatible and consistent with all aspects of the work assigned to the Group.

**Recommendation** – TAEIG should recommend that FAA Flight Standards revise FAR 121.579 as identified in Appendix 5: Additionally, similar changes should be considered for FAR 135.93 for Commuter and On-Demand airplanes. The Working Group feels it vitally important that this rule be updated in lockstep with the final release of the revisions to FAR 25.1329 and AC/ACJ 25.1329. Unless this is done, the operational rule FAR 121.579 will be inconsistent with the material developed by the FGSHWG, as both the operational rule (FAR 121.579) and AC/ACJ 25.1329, discuss how to calculate the autopilot Minimum Use Height (MUH). This could lead to significant confusion for both an applicant and the certifying authority if this material is used without the operational rule being updated. The FGSHWG also recommends that the JAA consider an Operational Rule similar to FAR 121.579, as proposed, to ensure a similar level of consistency.

- 5) During the course of the proposed rulemaking activity and the writing of the advisory material, it became apparent to the Working Group that there are many operational aspects of a flight guidance system that are not well understood by the flight crew. There was discussion within the Group on the level of information necessary, and the means, to make the information available to the flight crew. The role of the Airplane Flight Manual was discussed (i.e., regulated) along with various other documents such as Flight Crew Operations Manuals and Flight Crew Training Manuals. The Group believes that improvements are necessary in the material made available to the flight crew if improvements are to be made in reducing crew confusion and error.

The type of information that the Working Group feels should be made available to pilots include:

Overall flight deck design/operating philosophy. This would include such things as any high level concepts, such as a "quiet dark cockpit", or overall philosophy which drove the design of flight deck controls, displays, aural warnings, etc. In other words, an equal emphasis should be given to "Why" it is designed the way it is, in addition to "How" it is operated.

The Flight Guidance System Human/Machine Interface (HMI) design philosophy. Examples include:

The functionality of controls (e.g., the MD-11 Glareshield Control Panel controls "Pull to Engage, Push to Hold" concept).

The use of color or shapes for target bugs on the displays.

Additional information regarding the operation and behavior of the autoflight system, over and above the normal "system description". An area that causes confusion is the divergence of the pilot's expectations of how the system is going to operate vs. the actual system response. Examples include:

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- Detailed operation of the various flight modes (such as how does the Altitude Capture function work when a new altitude is dialed in when the flight guidance system is already in the process of capturing the old altitude, how the engaged flight guidance systems (both autopilot and autothrust) respond when they are in a Go Around mode and what must the pilot do to exit from that mode, any specific automatic mode reversions that may take the pilot by surprise).
- The response of not only the flight guidance system but also the basic airplane when a pilot manually overrides an engaged autopilot or autothrust system without first disengaging it.

(Possibly complex) interactions between systems. The interactions of such systems as flight director and autopilot, autopilot and autothrust, and autopilot and the flight management system are a source of pilot confusion. Examples include:

- A description of when the airplane speed is being controlled by thrust vs. when it is being controlled by pitch control.
- What autopilot mode will become active when it is engaged if a flight director has already been selected on.
- How the flight management system modes are integrated with the autopilot modes.

System response to and recovery from unusual flight conditions. Examples include:

- How the system will respond if the airplane exceeds the normal limits of FGS operation (e.g., 35 degrees bank, inverted flight) while the FGS system is engaged.
- How the system will respond if the pilot attempts to be engaged the system when the airplane is already outside the normal limits of operation (e.g., will the FGS system attempt to return the airplane to a normal attitude, will it disconnect immediately).

Speed/Envelope Protection. A detailed explanation should be provided of how speed protection (both high and low speed) and envelope protection (if provided) will operate. Examples include:

- How the system will respond with and without an operational autothrust system.
- Will the aircraft divert altitude to protect speed in all operational modes vs. only specific modes.
- Will the system disconnect at any time beyond the speed protection limits vs. always staying engaged and attempt to return the airplane within the normal operational limits.
- When the system will take active control vs. when the system relies on the pilot taking appropriate action based on a flight deck alert.
- Will the autothrust system automatically engage if not already engaged and speed protection is required.

**Recommendation** - This issue should be highlighted to the FAA Aircraft Evaluation Group (AEG) and JAA Operations communities with a recommendation that work should be undertaken with Industry to determine how to standardize the type and scope of material necessary to improve the flight crew's understanding of modern highly automated flight decks.

(Note: This type of recommendation has been made previously in the FAA Human Factors Team Report titled "The Interfaces Between Flightcrews and Modern Flight Deck Systems".)

- 6) The FAA developed autopilot interim policy to address many of the issues in the Working Group's Terms of Reference.

**Recommendation** - FAA interim Autopilot policy ANM-99-01 should be canceled upon publication of §25.1329 and AC/ACJ 25.1329.

- 7) The Working Group is aware that tasking is in work to update AC/AMJ 25-11 on display systems. The Working Group has developed generic Heads Up Display (HUD) criteria that should be considered in the

update to this AC/AMJ. Generic HUD criteria is contained in Appendix 4 of this Working Group Report. This material is currently contained in a generic FAA HUD Issue Paper, which is then applied to every certification program that involve a HUD. By placing this material in a published AC, the need for applying the generic Issue Paper to all HUD certification programs would be removed.

**Recommendation** - The general HUD criteria of Appendix 4 should be made available to the Avionics Harmonization Working Group tasked with updating the AC/AMJ 25-11.

- 8) The Working Group has defined “Flight Guidance Systems” as being the sum of the autopilot, flight director, and autothrust systems in both the proposed FAR/JAR 25.1329 and proposed accompanying advisory material. The autothrust function is the new addition, as it has not been treated as part of autopilot systems in the past. Nothing in the current AC 25.1329-1A or ACJ 25.1329 addresses any aspect of the autothrust system. However, the autothrust system interfaces with Propulsion Systems. FAR/JAR 25.901 regulates aspects of the autothrust system not covered by the proposed FAR/JAR 25.1329, as do other FAR’s, JAR’s, Advisory Circulars, FAA notices, and published policy statements. The Working Group concluded that the autothrust system has never been treated as a system and that the current published material governing its design and certification is scattered, not of the same type (e.g., Advisory Circular, rule, policy statement), and has not been rigorously examined for potential areas of confusion, overlap, and conflict.

**Recommendation** - Consideration should be given to performing a detailed study of the rules, advisory material, notices, policy, etc. that govern the certification of an autothrust system with the intent of:

- Determining what currently published material deals with the autothrust system.
- Determining that the currently published material adequately covers all aspects of the autothrust system.
- Determining if there are any overlaps in coverage, or more importantly, any conflicts in the currently published material.
- If necessary, produce additional Advisory Circular material to cover all aspects of the autothrust system that are currently not covered by the FGS Advisory Circular, specifically those aspects that are currently covered only by FAR’s, notices, and policy statements. The ultimate goal should be to have all aspects of the autothrust system covered in Advisory Circulars, so that there is no need to depend on notices and policy statements.

*Note:* The concern is that an applicant, when looking at the proposed AC/ACJ 25-1329, may not understand that there is additional material that must be considered when designing and certifying an autothrust system, or where it may be found.

- Ensuring that there is sufficient cross-referencing between Advisory Circulars so that an applicant understands, without undue difficulty, where additional advisory material may be found concerning autothrust systems.